Scope of Work, Fee & Schedule for Rio De Flag Watershed Integrated Hydrologic & Hydraulic Model Interface Tasks

From Civil Design & Engineering (CD&E), with DHI

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In this document, CD&E provides a narrative scope and schedule for the City of Flagstaff (CoF) Rio De Flag (RDF) Watershed Integrated Hydrologic & Hydraulic *Model Interface Tasks*. These *Model Interface Tasks* are as follow:

Task 1 – Web-Based Model Interface for Public;

Task 2 – Modeling Interface for Stakeholders.

These tasks are intended to build on and supplement the CoF's base project, which is the RDF Watershed Integrated Hydrologic and Hydraulic Model, and satisfy the CoF's Stormwater Management's requirement for:

1) providing web-based public access to selected H&H model input and output;
2) providing stakeholder ability to modify, using their own GIS software and skills, digital H&H model input files, submit those modified files to the CoF for model simulations, to be completed by CoF staff, and receive the digital output files for their own use.

Model Interface Task 1. Web-Based Model Information Access for Public

The CoF seeks a "viewer" for web-based public access to representative H&H model input and output – something similar to, but not as complex, as a web-based viewer in development at the Flood Control District of Maricopa County. The latter has required over 1.5 years of effort and, presumably, a significant budget for internal and consultant resources and engagement. Further, it represents a viewer designed for both public and consultant access, with considerably greater functionality than what is contemplated here. The term 'public' is used to identify interested and engaged members of the public who generally do not own or use GIS or H&H software.

During development, calibration and application of the distributed hydrologic/hydraulic MIKESHE/MIKE 11 model for the RDF (base proposal Tasks 2 through 4), CD&E will develop a web page (viewer), using ESRI's *Web AppBuilder for ArcGIS*. A sample *Web AppBuilder for ArcGIS* product can be seen here:

https://strathconacounty.maps.arcgis.com/apps/webappviewer/index.html?id=ccb2270a9797497f9fd065fe0cd7bf4c

The viewer will consist of a web page that provides access to imagery and other standard raster and vector GIS data, together with selected model input and output from Tasks 3 & 4 of the base project that the City wishes to share with the public. It contains, zooming and panning functionality, layers, links and widgets.

We anticipate and budget for two model scenarios. This web page would be hosted by the CoF on its servers. We assume an initial meeting with CoF staff, including a webmaster. The deliverable would consist of all digital content files needed for the webmaster to post the content to the CoF website – so that a member of the public would be able to access the web page and view the data. Links from

existing CoF webpages to the new webpage, and search engine indexing for the new webpage would be provided by the CoF Webmaster. CD&E will provide a half-day orientation session to CoF staff to explain how the web page was created, and its functionality developed, so that staff will be able to properly maintain and revise it as requested and necessary.

Model Interface Task 2. Modeling Interface for Stakeholders

The CoF seeks a *modeling interface for stakeholders*, by means of which a limited group of a half-dozen or so stakeholders (Forest Service, USGS, NAU, others) may reformat, using their own software (i.e., Excel, ESRI ArcGIS software), spatial and/or time-varying model input data for customized scenarios of interest to their organization. The CoF would then run MIKE SHE / MIKE 11 simulations using the revised model input data, and provide digital output files to the stakeholder(s) for their viewing, using ArcGIS software, and use. A relatively seamless, easy to use and straightforward modeling interface for stakeholders is sought. We anticipate that some programming may be required to develop an interface that is at least partially automated – to minimize use of CoF resources.

Activity 1: CD&E and the CoF will canvas stakeholders on their likely needs and uses of the model as set up, or modified for their use. This would involve assessing the types of model simulations they might be interested in, which would dictate what data inputs they would need to change (both spatial and temporal), and what outputs they'd want to see (there are various ways to display model outputs). CD&E will research alternatives for the interface, and provide recommendations in the form of a technical memorandum. The memorandum will include our recommendation(s) concerning a preferred solution, and possibly several alternatives for CoF consideration.

Activity 2: Assuming that the CoF decides to move forward with the recommended (or another) process, CD&E will develop, test, demonstrate and implement the process's application using input and output data sets developed as part of the main (base) project. CD&E would also host a half-day training session for CoF staff and stakeholders.

Model Input: For purposes of developing the scope/budget here, CD&E assumes that stakeholders will make changes to **only** the MIKE SHE gridded model inputs, which could include:

a) Varying the types of vegetation at any location and in time. This could be useful in evaluating effects of changing vegetation distributions due to fire, or testing the impact(s) of land use modifications on hydrologic and hydraulic response over time. This can be done by adjusting appropriate 'vegetation code' attributes within a single MIKE SHE grid-based polygon shapefile that relate to a vegetation database that also includes details on time-varying vegetation root depths, Leaf Area Index, and crop coefficients (K_c) and other constant parameters, e.g., percentage of Canopy Interception.
b) Varying the types of soils (or associated soil parameters) at any location. Effects on hydrologic/hydraulic response to post-fire conditions, or to other land use modifications could be assessed. Changes in soil types can also be made similar to changes in vegetation,

which varies by model grid cell, by also adjusting specific ArcGIS shapefile attributes referencing specific soil codes, which are tied to a MIKE SHE soils database. Within the soils database, specific soil parameters can be adjusted by stakeholders to meet their needs (i.e., different Green-Ampt soil parameters, or different soil horizons/depths with different unsaturated zone hydraulic properties if using the full Richards-based unsaturated zone flow option instead of the Green-Ampt method).

c) Climate:
    a. For single, non-distributed storm events, stakeholders can provide specific time series to CoF (i.e., design storms, or other).
    b. For distributed single storm events, stakeholders could provide spatially distributed time-varying precipitation in the form of raster images at specific time steps (i.e., NexRAD), which can be easily converted by CoF into distributed inputs for the model.

CD&E assumes stakeholders will not make changes to the MIKE 11 model inputs (i.e., cross-sections, stream locations, diversions, structures, distributed resistance, etc.) as this would involve more CoF staff time to prepare custom MIKE 11 input.

Model Output: CD&E assumes stakeholders will be interested in accessing both gridded MIKE SHE model output, and time-varying stage and discharge output calculated at alternating MIKE 11 numerical grid points.

Gridded Output: For accessing model output, existing DHI MIKE SHE tools are available to convert selected gridded model output into static or time-varying ArcGIS raster images, which can then be directly imported into ArcGIS. CD&E assumes all stakeholders have full access to ArcGIS and are fully capable of using it to develop their own customized viewing of output. In addition, additional DHI tools exist to further process gridded spatial output data (i.e., calculating statistical measures of time-varying output at each model grid) and to convert these spatial plots into ArcGIS raster images for import.

CD&E assumes the following time-varying MIKE SHE model gridded output would be generated for stakeholders:

1) Surface Evaporation
2) Plant Transpiration
3) Moisture Content
4) Infiltration
5) Surface Overland Depth
6) Surface Overland Flow Velocity (x and y directions)
7) Contributions of Overland Flow to MIKE 11 Stream Reach.

MIKE 11 Hydraulic Output: At a minimum, CoF can provide stakeholders time-series of stage or discharge at specific hydraulic network nodes throughout the model, if stakeholders provide

specific locations in an ArcGIS shapefile. CoF would then enter these locations in the model input. Once finished, the model automatically generates output time-series of desired output that can be easily converted into a text format, easily input by stakeholders into spreadsheet software like MS Excel. If stakeholders would like to see all stage and discharge output (typically large files), DHI has tools already developed which read the binary MIKE 11 output and convert this into ASCII text files, easily input into spreadsheet or databases (i.e., MS Access) for further visualization/evaluation.

Output Viewer: Several options are available to stakeholders to view spatially distributed output, ranging from using open-source GIS, to ESRI software, to DHI's Information Management Systems, or fully customizable DHI Decision Support Systems (DSS). CD&E assumes that, at a minimum, each stakeholder will have access to their own ArcGIS/ArcINFO GIS tools and can visualize all spatial data transferred between the CoF and the stakeholder.

Proposed Budget

Completion of the Model Interface Task 1 (public web-based model I/O viewer) will cost $22,468 (fixed fee).

Completion of Activity 1 of Model Interface Task 2 will cost $8,278 (fixed fee). Completion of Activity 2 of Model Interface Task 2 will cost $26,875 – assuming that stakeholders will edit and view input data and view output data using their own ArcGIS software.

Proposed Schedule

Please see the attached schedule.

Task No.	Task	Activity	Sept				Oct				Nov					Dec			
			9/7	9/14	9/21	9/28	10/5	10/12	10/19	10/26	11/2	11/9	11/16	11/23	11/30	12/7	12/14	12/21	12/28
1	Web-Based Model Interface for Public	Implementation																	
2	Modeling Interface for Stakeholders	Research & Recommendations																	
		Implementation																	